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Utility Programs for Generating the Hershey Character Fonts on Microcomputers and Laboratory Plotters

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Utility Programs for Generating the Hershey Character Fonts on Microcomputers and Laboratory Plotters

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NBS technical note
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ABSTRACT

Two programs are described that allow for the storage and manipulation of digitized fonts of graphic arts symbols and characters on the Apple II computer system. These fonts are based on the work of A. V. Hershey and provide the user with a repertory of digitized characters suitable for use in the preparation of camera-ready illustration in the laboratory environment. The programs described contain routines for reading files of the Hershey coordinates, storing them as text files, displaying them as individual characters or combined text on the high resolution display, and two methods for editing them or creating special symbols and graphics.

Key words: Applesoft basic programs; camera-ready illustrations; digitized graphic symbols; Hershey character fonts; microcomputers.

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on
Microcomputers and Laboratory Plotters

INTRODUCTION

With the advent of microcomputers able to drive inexpensive x-y plotters, it is now possible for scientists to produce camera ready illustrations in their own laboratory. Such drawings have, in the past, required costly and time consuming drafting and hand lettering by graphics artists.

The ingredients of such an in-house facility, in addition to the microcomputer and plotter, are:

- a) a collection of mechanical drafting routines
- b) a repertory of graphic arts fonts in digitized form
- c) computer programs to store, retrieve, edit, and display them on video terminals, printers, and plotters.

Mechanical drafting and data handling routines have been under development for some time and are the subject of a forthcoming report. For the character digitization, we have been able to draw on the pioneering and definitive work of Dr. Allen V. Hershey as subsequently presented by Wolcott and Hilsenrath. The third item on the above list, the software required to digitize and display the characters, is the subject of this report. This report describes two programs for the Apple II computer^{*} operating under the disk operating system (DOS 3.3). The first program, which is treated in detail, contains routines for reading files of Hershey coordinates and storing them in a more compact format as text files, displaying individual characters or complete fonts on the hires (high resolution) screen, and two methods for editing or

* In this report certain commercial products are referenced by name. These references are for informational purposes only and do not imply that they are necessarily the best available for the purpose or do not imply endorsement by NBS.

making new characters. This program is the main subject of this report. The second program, which is treated as an appendix to this paper, details utilities for combining individual Hershey characters on the hires screen for the creation of logos for use in other programs. It is meant to be illustrative of some of the possible applications of the Hershey fonts.

THE ORIGIN AND DIFFUSION OF THE HERSHEY FONTS

In the mid sixties, Dr. Allen V. Hershey undertook a project at the Naval Weapons Laboratory in Dahlgren, Virginia, to automate the preparation of his highly mathematical reports and those of others involving complex chemical structures and electrical diagrams. That work produced a comprehensive suite of FORTRAN typographic programs; a repertory of occidental alphabets and oriental ideograms, cartographic symbols, etc. The typographic system has been fully documented in a series of NWL reports (1-5). Early applications of the system are to be found in Hershey's own scientific publications (6-10) in which the system was honed.

More than 120 copies of the original system have been distributed (largely in card decks) to universities, industries, and government laboratories. Applications range from computer assisted typesetting to computer driven engraving machines with the output characters appearing on all types of printers and plotters (11). Although Hershey's characters have been incorporated in many commercial graphics packages, unfortunately, they do not all acknowledge the source. NBS has used the system for well over ten years, and in 1976 undertook the publication, in book form (12), of the occidental fonts, and the distribution on magnetic tape (13), of the coordinates for both the occidental and oriental characters. This was followed in 1978 by the publication of a subset incorporated in a Technical Note by N.W. Wolcott entitled "FORTRAN IV Enhanced Character Graphics" (14). Since then, the economic advantage of in-laboratory production of camera ready illustrations for research papers has led to the

incorporation of the Hershey character fonts as user defined characters under the Hewlett-Packard Graphics Language (15), and in a system for use on the Apple II computer system. It is this latter application which is the subject of this report.

Extensive use of the Hershey characters was made in 1981 by Claude A. Kagan who succeeded in adapting them for a variety of microcomputer systems, including the Apple II operating under CPM (16). A more recent application of the Hershey character set has been made by Daniel Macero and associates (17) who have modified a line printer to provide a resolution of 100 dots-per-inch horizontally and 72 dots-per-inch vertically.

THE CURRENT PROGRAMS

The present report details a technique for using the Hershey characters with the Apple II computer system operating under the Apple Disk Operating System, DOS 3.3 (18). Although the High Resolution Character Generator Routine supplied as part of the Applesoft Toolkit (19) provides for the creation and retrieval of characters and special symbols, these characters are limited to a 7x8 dot matrix format and are designed to be used on the high resolution graphics screen.

Consequently, we present in this report two programs that will allow the storage of the Hershey characters in a compact format as text files (CANDY APPLE) and their subsequent use as input to the hires graphics screen (CANDY WRAPPER). The first of these programs is described in some detail since it provides the means of storing the digitized character coordinates as well as a technique for creation of special characters and symbols. The second program is included as an appendix to illustrate a particular use of the Hershey characters. A more extensive program describing their use for digital plotting is currently being documented.

Although some effort has been expended to faithfully reproduce the character fonts tabulated by Wolcott and Hilsenrath,

we have made some reasonably liberal changes in these fonts to provide for our particular application.

THE HERSHEY CHARACTERS

As tabulated by Wolcott and Hilsenrath (12-13), the Hershey characters consist of a series of numbers which indicate the end points of straight line segments which are used to define alphanumeric and special symbols. Each succeeding number pair indicates the coordinates of the next dot to be connected in a connect the dots scheme. For example, the vectors that correspond to the capital A illustrated in Figure 1, are given in the following format:

```
1: -5    5:  0    -5: -4    4:-64    0:  0    -5:  4    4:-64    0:
      -2    1:  2    1:-64 -64:
```

In this representation, the first number is the character number in the Hershey set, the first pair of numbers indicates the x coordinates of the limits of the character (-5,5), and the actual character begins at the next coordinate location (x=0,y=-5). It should be noted, in this context, that the coordinates are determined in a system where the x-axis is increasing from left to right, and the y-axis increases from top to bottom in accordance with standard printing notation where vertical deflections increase down the page. This is also the convention utilized by the Apple II for its graphics displays. The origin of the coordinate system is located approximately at the center of the character. Succeeding pairs of coordinates indicate the next point to be connected to draw the figure. A coordinate pair of -64 0 indicates that the next line is not to be drawn, but the stylus is to be moved to the next location. Finally, a coordinate pair of -64 -64 completes the figure.

For use on the Apple II computer system, we have chosen to store the characters as strings in a dimensioned array named X\$. In order that the length of any particular string not exceed the maximum limit of 255 characters allowed, we have chosen to store

not the coordinates of the next point, but the offset required to arrive at that location. In addition, the character numbers have been deleted. In general, each string consists of a series of ASCII characters in the format:

W XY ? XY XY XY ? XY XY ? XY

where the first character, W, indicates the width of the character, the next pair, XY, indicates the offset to the start of the character, the character, ?, indicates a change of pen status, etc. In order to obtain the maximum possible flexibility in the storage of the characters, each character stored is the ASCII character corresponding to the offset +93 (i.e. an offset of +1 is stored as CHR\$(94)=^). In this scheme then, the string corresponding to the character, A, given by the Hershey vectors above is stored as:

'""?YT?!&?!t?WZ?!J?!^

where the vectors are now stored in a format where positive vertical displacements are in the upward direction. Note that this technique allows the character to be stored in 22 bytes whereas the previous representation would require at least 33 bytes even if the foregoing compression scheme were used to represent pen changes. In addition, the final vectors represent the offset necessary to advance the pen to the right hand character limit.

CANDY APPLE

The program for manipulating these Hershey text files is given in Listing 1 and is written in Applesoft Basic (20). In general, the program is self-explanatory and menu-driven; it is broken up into the following sections:

Line numbers	Program function
10-199	Main menu and initialization; also contains the disk assignment routine.
1000-1460	Hershey character input routine using the tabulated Hershey vectors.
2000-2130	Write font to disk as a text file.
3000-3260	Routines to modify a font.

4000-4070	Font hires display index routine.
5000-5460	Font edit routines; also contains cursor input routines.
6000-6180	Hires routine to display font.
7000-7110	Read font from disk.
8000-8090	Display single character as it is input.
9000-9010	Catalog input disk.
10000-10000	Exit routine.
11000-11060	Hires screen swap routines.

In the following sections, each segment of the program will be examined in more detail. Although some effort was made to write the most efficient code, the program was designed to be user friendly and hopefully to contain as small a number of bugs as possible. In Listing 2, the variable documentation program of South Western Data Systems (21) was used to document the usage of all the variables used in the program. Reference to this listing will be useful in the following discussions.

Lines 10-999 : THE MAIN MENU AND INITIALIZATION ROUTINES

This section of the program is used to display the main menu and to determine the disk drives that will be used for both input and output of the data. Before running the main body of the program however, the entire program is relocated so that the computer stores the Applesoft code beginning at memory location 24577 (\$6001) using the &LOMEM: utility of Konzen (22). This utility shifts the entire Applesoft program and variable space above the locations that are needed for both pages of the hires graphics. After this shift, the program initializes the font array (line 50), pokes a hires shape table into locations 768-777 (\$0300-\$0309) and loads the appropriate hooks to the table on page 0. This shape is used as a cursor for the input of character vectors in lines 5000-5460. Lines 80-90 input the appropriate disk drive information and the rest of the section displays the main menu. The main menu is self-explanatory for the most part, and contains options that allow the user to CREATE, MODIFY, EDIT, or DISPLAY a font as well as perform certain disk operations.

Lines 1000-1460 : HERSHEY VECTOR INPUT

This section contains the routines to input a character using the vectors listed by Wolcott and Hilsenrath. Initially, however, the user is given the choice to input these vectors or to enter the character using the character edit routines of the 5000 section. The directions given for the Hershey coordinate input indicate the procedure to follow to enter the data. Line 1100 is used to eliminate the initialization of the character number, L, if the font is being edited or modified. Line 1120 branches to the subroutine that draws the hires graphics that illustrates the character as it is input. The appropriate x- and y-offsets are entered using the GET command of Applesoft to input a character string. Inclusion in the string of the left arrow requires the re-entry of the entire string. Entering a space for the horizontal input signals a change of pen position for the following coordinate move only (the equivalent of :-64 0: in the Wolcott notation). Entering the symbol, /, for the horizontal coordinate signals the end of the character (:-64 -64:), and enters the appropriate vectors to advance the pen to the location of the right marker. The first two vectors input indicate the left and right markers respectively, and are used to determine the character width, W, in line 1360. The previous x and y coordinates are stored in the variables XT and YT and are used in line 1370 to determine the current x and y deflections. Line 1400 generates the string by concatenating the current values to the string X\$(L). The rest of this section increments the character number, L, and continues the input process. These routines are terminated in one of two fashions; if the horizontal coordinate is entered as E, then the current string is set equal to "EOF", and the user may write the font to the disk or return to the main menu (lines 1230-1250); if the routine has been called by the EDIT or MODIFY routines, after the insertion of a single character, control is returned to the calling routine (line 1160).

Lines 2000-2130 : WRITE FONT TO DISK

This section is a standard routine to output the font to the disk specified by drive number D0. The initial lines of this routine give the user the option of changing either the filename or the disk drive number. All routines in this program assume that the disk controller card is inserted in slot #6. After completion of the write routine, control is returned to the main menu beginning at line 100.

Lines 3000-3260 : ROUTINES TO MODIFY A FONT

The routines in this section allow the user to modify a font in a number of ways. The menu for this section (lines 3000-3050) indicates that the user may APPEND to a font, INSERT a character, REPLACE a character, REMOVE a character, or EXIT to the display routine of line 4000. In all modes but EXIT, the font insert flag, (FI), is set and the font is displayed. If the APPEND mode is selected, then the character location variable, L, is set to the end of the font and control is passed to the character input routine of line 1000- (line 3100). In the INSERT, REPLACE, and REMOVE modes, the following procedures take place:

INSERT (line 3150-) requests the location to insert, LO, moves all font characters from LO to the end of the font, LMAX, up one location (line 3170), displays the adjusted font and saves it on hires page 2 (line 3180), jumps to the character input routine for the inputting of one character, displays the new font (line 3220), and returns to the menu.

REPLACE (line 3230-) requests the character number to replace, LO, displays the font (line 3210), jumps to the input routine to input a character, displays the new font, and returns to the menu.

REMOVE (line 3230-) requests the character number to delete, LO, moves all characters from LO to the end of the font, LMAX, down 1 (line 3250), displays the new font (line 3260), and returns to the menu.

In all of these routines, the current font is saved in the memory space reserved for the hires page 2 graphics (\$4000-\$6000) by the hires page flip routines of lines 11000-.

Lines 4000-4070 : DISPLAY THE FONT DRIVING ROUTINES

The routines of this section are used to display the fonts on the hires graphics pages. In line 4000, a jump is made to the disk access routine at 7000 to input the font from the disk if a new filename is used to access the data. The routine of line 4010 displays the font, N\$, character by character, if the memory flag, MF, is not set. If the memory flag is set, then the font has been saved on hires page 2, and a call to the memory flip routines at 11000- recalls it for display. Line 4030 returns control to the calling routine if the font input flag, FI, is set. Otherwise, the remainder of the routine allows the user to either write the font to the disk, or return to the main menu.

Lines 5000-5460: THE CHARACTER EDIT ROUTINE

These routines allow the user to edit a character by entering either the Hershey coordinates or by using a hires cursor input. Line 5040 displays the entire font and the user is prompted (line 5060), to enter the number of the character to be changed. This character is then displayed in a magnified version by the routine of lines 8000-. Figure 2 illustrates this display for the Gothic letter N. Lines 5070-5120 perform this display by determining the appropriate x and y coordinates by decoding the string describing the character. After the character display, line 5125 gives the user the option of returning to the start of the edit routine if the wrong character has been selected to edit. Otherwise, the user has the option of either entering the Hershey coordinates (lines 1000-), or redrawing the character using the cursor control. The cursor control input technique allows the generation of custom characters by manipulating a high resolution cursor on the high resolution display. Initially, the user is requested to enter the limits of the character by defining the left and right marker locations (lines 5150-5190). The cursor is then placed on the left marker, and may be moved to the appropriate location by use of the I, J, K, and M keys of the keyboard. The current status of the pen is given on the text display and may be changed at any time by striking the space bar.

These cursor moves and the pen position are entered by the GET input command of line 5250. When the cursor is positioned at the appropriate position, the return key draws a line (with the appropriate pen mode) from the previous location to the current cursor location, enters the values into the character string, and returns for the next line input (lines 5340-5350). As in the Hershey input mode, / terminates the character. If the cursor is not centered at the right marker, vectors are added to the string to complete this move (lines 5360-5380). After verification of the validity of the character, the font is displayed and the routine is terminated if either the font input, FI, or the edit flag, EF, is set. The remainder of the routine is used to enter characters under cursor control if the NEW FONT option of the main menu is being performed. Note also, that the new font is saved by the page transfer routine of lines 11000-.

Lines 6000-6180 : HIRES FONT DISPLAY ROUTINES

The routines of this section display the members of a font on hires page 1 depending on their location in the font. Lines 6000-6020 determine the location at which the character is to be displayed (with 50 characters displayed at a time), line 6030 removes any previously displayed character at that location, and the remainder of the routine decodes the character string and draws the character. The variables XP and YP are used for the current cursor location, and DX and DY are used for the offset to the next location. As always, the penflag, PF, is used to determine whether the vector is to be plotted with the pen up (HCOLOR BLACK) or down (HCOLOR WHITE).

Lines 7000-7110 : FONT INPUT ROUTINES

The font N\$ is inputted from disk drive DI, if it is not already saved on hires page 2. If the font is to be brought in from the disk, the memory flag, MF, is reset and the data pointer is restored. Otherwise, the routine is straightforward and the file is read until the occurrence of the end of file character string, EOF. At the completion of the read routine, the file name is saved in the variable O\$.

Lines 8000-8090 : HIRES SINGLE CHARACTER GRAPHICS

These routines draw the hires single characters that are input either by using the Hershey vectors or the cursor control. Lines 8000-8050 draw the box for the display of the character as illustrated in Fig. 1. In this representation, each dot corresponds to one unit in the character. Lines 8060-8090 plot the figure from the decoded character string values. Line 8060 sets the magnification, M, to 5, and plots the left and right boundaries relative to the center of the display (x=140,y=80). Line 8070 sets the next point as the center of the left marker. Subsequent values of X and Y are then plotted with the appropriate pen control by the remainder of the routine. The current location is stored in the variables X1 and Y1.

Lines 9000-9010 : CATALOG

This routine lists the catalog of the disk currently specified as the input disk, DI.

Line 10000 : END

This is a standard exit routine.

Lines 11000-11060 : THE HIRES MEMORY FLIP ROUTINE

This routine copies the contents of hires page 1 to hires page 2 or vice versa. The starting address, the ending address, and the first address of the destination field are read from the data statement at line 11060. Depending on the state of the memory flag, MF, page 1 is sent to page 2 (MF=0) or vice versa (MF=1). The microprocessor's y and x register locations are zeroed by the POKE statements of line 11030 and the Program Counter is initialized to point to the Apple Monitor MOVE routine (\$FE2C) which is then called by the Apple Monitor GO routine (\$FEB6).

THE FONTS

The fonts that have currently been converted to the notation described in this report, are for the most part taken directly from the tables of Wolcott and Hilsenrath. For convenience, they are divided up into 32 character segments which we have chosen to name numbers, small, caps, and greek. Figures 3 to 8 illustrate the characters that make up the following fonts (in each subset, the characters are numbered from 1 to 32):

MATH SYMBOLS... A collection of commonly used symbols in mathematics taken from the Hershey characters between no.'s 2225 and 2278 (as referenced in the Wolcott and Hilsenrath tables).

CARTO FONT... Numbers and caps are taken from the Hershey cartographic symbols from no.'s 1 to 234. Although the Hershey fonts do not include small letters, these were custom designed and included as part of this font.

INDEX FONT... The members of this font were taken from the complex index size Hershey characters from no.'s 1001 to 1150.

SIMPLEX FONT... The members of this set were taken from the print size simplex Hershey characters from no.'s 501 to 651.

COMPLEX FONT... The members of this font were taken from the print size complex Hershey characters from no.'s 2200 to 2224.

GOTHIC FONT... This set is a mixture of two different Hershey fonts. The numbers are from the print size gothic Hershey characters from no.'s 3700 to 3729, while the small letters and caps are from the Hershey Italian gothic set (no.'s 3901 to 3950) and the Hershey print size English gothic set (no.'s 3700 to 3750), respectively.

SCRIPT FONT... This font is taken from the print size Hershey complex script characters from no.'s 2550 to 2576, 2650 to 2676, and 2750 to 2776.

CONCLUSION

Although the fonts that we have stored as text files using CANDY APPLE are composed mainly of the Hershey characters, it is possible using this program to custom design graphics symbols. In the complex caps font illustrated in Fig. 6, the characters numbered from 28 to 32 are custom designed for logos used at NBS. This customization can be accomplished either by drawing the desired figure on graph paper and then calculating the desired coordinates or by freehand drawing using the cursor input routines of lines 5000-. The current report illustrates over 700 characters which are stored on disk as text files. Listing 3 gives a catalog of the disk containing the programs CANDY APPLE and &LOMEM: as well as the fonts. Reference to this listing shows that the programs need 36 sectors for storage and the fonts use an additional 181 sectors leaving more than 270 sectors available for applications programs. Such an application program, CANDY WRAPPER, is described in Appendix A. Copies of CANDY APPLE, &LOMEM:, CANDY WRAPPER, and the fonts may be obtained by contacting the authors at the following mailing address:

C-216, Bldg. 245
National Bureau of Standards
Washington, DC 20234

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```

0330- A9 4C 8D F5 03 A9 40 8D F6 03 A9 03 8D F7 03 60
0340- A9 A4 20 C0 DE 20 67 DD 20 52 E7 A5 67 85 96 A5
0350- B0 85 97 C6 96 38 A5 50 85 94 E5 67 85 50 A5 51
0360- 85 95 E5 68 85 51 A5 AF E5 67 A8 A5 B0 E5 68 AA
0370- 18 65 95 85 95 C8 D0 01 E8 E8 C8 20 C3 D3 A2 69
0380- 20 C1 03 A2 AF 20 C1 03 A2 67 20 C1 03 A2 79 20
0390- C1 03 A5 B9 C9 02 F0 05 A2 B8 20 C1 03 A5 67 A4
03A0- 65 85 5E 84 5F A0 00 38 B1 5E 65 50 91 5E AA C8
03B0- B1 5E F0 0A 65 51 91 5E 86 5E 85 5F 90 E7 4C 6C
03C0- D6 38 B5 00 65 50 95 00 B5 01 65 51 95 01 60

```

The utility is invoked by the ampersand call &LOMEM: no. where no. is the first memory location for the relocated Applesoft program (See Line 20 of Candy Apple).

APPENDIX A

In order to illustrate the use of the character fonts created by use of the CANDY APPLE program, we have written a program named CANDY WRAPPER to place these characters anywhere on the hires screen. This program is given in Listing 4 and uses some of the routines developed for CANDY APPLE to decode and plot the characters. The program is menu driven with the following options available to the user:

1. Change the disk drives for inputting and outputting a hires picture.
2. Display the catalog of a selected disk drive.
3. Set the environment for drawing the hires characters. This option allows the user to select foreground and background colors from the hires color set.
4. Load a previously saved hires picture from disk.
5. Save a hires picture to disk.
6. Add text to a hires picture.
7. Change from one Hershey font to another.
8. Clear the hires screen.
9. Display the hires screen.
10. Exit the program.

In general, the program is self-explanatory and uses a non-destructive hires cursor to position the start of the Hershey character on the screen. The program does not clear the hires screen at initialization so that a previously generated picture may be left in page 1 for the addition of text. In addition, the program is relocated to protect the primary hires page. For convenience, the fonts are read in as 32 character increments called small, caps, numbers, and greek as stored by the program CANDY APPLE. Figure 9 illustrates a logo produced by CANDY WRAPPER as a frontispiece for a listing of CANDY APPLE. This figure and all others used in this report were produced by a screen dump of the hires graphic page produced by the programs to a dot-matrix printer.

Listing 1. Candy Apple program.

```

10 TEXT : HOME : HTAB (14): VTAB (10): PRINT "CANDY APPLE": REM A HERSHE
  Y CHARACTER FILEHANDLER FOR THE APPLE II
20 PRINT CHR$ (4):"BRUN LOMEM:" & LOMEM: 24576: REM RELOCATES A/S T
  O START AT $6000 (ABOVE HGR 1 & 2)
30 BELL$ = CHR$ (7)
40 HOME : HGR : HGR2
50 D$ = CHR$ (4): DIM X$(160): REM SAVE SPACE FOR 5 FONTS OF 32 CHARACTE
  RS
60 POKE 768,01: POKE 769,00: POKE 770,04: POKE 771,00: POKE 772,58: POKE
  773,36: POKE 774,45: POKE 775,54: POKE 776,07: POKE 777,0: POKE 232,0
  0: POKE 233,03: REM LOAD SHAPE TABLE FOR HIRES CURSOR
70 TEXT : HOME : HTAB (14): VTAB (10): PRINT "CANDY APPLE": REM START AN
  D INIT. DISK DRIVES
80 PRINT BELL$: INPUT "READ FROM DISK DRIVE:";DI: IF DI < 1 OR DI > 2 THEN
  80
90 PRINT BELL$: INPUT "WRITE TO DISK DRIVE:";DO: IF DO < 1 OR DO > 2 THEN
  90
100 HOME : REM MAIN MENU
110 PRINT : PRINT "DO YOU WISH TO....": PRINT : PRINT TAB( 10);"1.CREATE
  A NEW FONT": PRINT : PRINT TAB( 10);"2.MODIFY AN EXISTING FONT": PRINT
  : PRINT TAB( 10);"3.EDIT FONT CHARACTERS"
120 PRINT : PRINT TAB( 10);"4.DISPLAY (TRANSFER) A FONT": PRINT : PRINT
  TAB( 10);"5.ASSIGN DISK DRIVES": PRINT : PRINT TAB( 10);"6.CATALOG
  OF DISK :";DI: PRINT : PRINT TAB( 10);"7.QUIT": PRINT BELL$: INPUT "
  WHICH?";C
130 IF C < 1 OR C > 7 THEN 100
140 IF C > 4 THEN 180
150 PRINT : PRINT BELL$;: IF N$ < > " " THEN VTAB (23): PRINT "RETURN US
  ES FILENAME: ";O$
160 VTAB (21): INPUT "FILENAME: ";N$: IF LEN (N$) = 0 THEN N$ = O$
165 O$ = N$
170 HOME
180 ON C GOTO 999,3000,5000,4000,70,9000,10000
999 HGR2 : TEXT
1000 PRINT "* ROUTINE TO CREATE AN HERSHEY FILE NAME: ";N$
1010 PRINT BELL$: PRINT "INPUT HERSHEY COOR.<H> OR USE CURSOR CONTROL<
  C>?";: GET A$: PRINT A$: IF A$ < > "H" AND A$ < > "C" THEN 1010
1020 EF = 0: IF A$ = "C" THEN EF = 1
1030 IF EF THEN 1090
1040 PRINT BELL$: PRINT "* INPUT THE HERSHEY COORDINATE PAIRS ON THE PROM
  PTING BELL "
1050 PRINT : PRINT "* THE CHARACTER READ ROUTINE ASSUMES THAT THE PEN
  STARTS IN THE UP POSITION. TO SIGNAL A PEN CHANGE, INSERT A SPACE BE
  TWEEN THE COORDINATE PAIRS."
1060 PRINT : PRINT "* TO SIGNAL THE END OF THE CHARACTER INSERT THE DE
  LIMITER /"
1070 PRINT : PRINT "* TO SIGNAL THE END OF THE FILE ENTER THE EOF CHARA
  CTER <E>."
1080 PRINT : PRINT "* THE FIRST COORDINATE PAIR INDICATES THE WIDTH OF
  THE CHARACTER...TO ENTER A NULL CHARACTER ENTER 0,0"
1090 PRINT BELL$: PRINT "READY? ";: GET Q$: PRINT Q$: IF Q$ < > "Y" THEN
  HOME : GOTO 1000
1100 HOME : IF FI THEN 1120
1110 IF C THEN L = 0
1120 GOSUB 8000: PRINT TAB( 10);"FILENAME:";N$;A$ = ""
1130 PRINT : PRINT TAB( 10);"CHARACTER STRING NO:";L:X$(L) = "":Z = FRE
  (0):PF = 0
1140 IF L = 160 THEN X$ = "E": GOTO 1220

```

```

1150 IF EF THEN A$ = "N": GOSUB 5180: IF EF = 0 THEN X$ = "E": GOTO 1220
1160 IF EF AND FI THEN RETURN
1170 IF EF THEN L = L + 1: GOTO 1120
1180 X$ = "": Y$ = ""
1190 PRINT BELL$: TAB( 5): "HOR.COOR:";
1200 PRINT A$:: GET A$: IF A$ < > " " AND A$ < > CHR$ (13) THEN X$ = X
$ + A$: GOTO 1200
1210 IF RIGHT$ (X$,1) = CHR$ (8) THEN PRINT BELL$: "REINPUT ": X$ = "":
GOTO 1190
1220 IF X$ = "E" THEN X$(L) = "EOF": PRINT "ND OF FILE...": PRINT : LMAX =
L
1230 IF X$ = "E" THEN PRINT BELL$: "WRITE TO DISK<W> OR RETURN TO MENU<M>
?": GET Q$: PRINT Q$: IF Q$ < > "W" AND Q$ < > "M" THEN 1230
1240 IF Q$ = "W" THEN 2000
1250 IF Q$ = "M" THEN TEXT : GOTO 100
1290 IF X$ = "" THEN X$(L) = X$(L) + CHR$ (127): PF = NOT (PF): PRINT BE
LL$: "PEN CONT.": GOTO 1180
1300 IF X$ = "/" AND LEN (X$(L)) THEN X$(L) = X$(L) + CHR$ (127) + CHR$
(XF - XT + 93) + CHR$ (93 - YT): GOTO 1420
1310 IF X$ = "/" AND LEN (X$(L)) = 0 THEN PRINT BELL$: "ERROR...REINPUT"
: GOTO 1170
1320 PRINT BELL$: " VERT.COOR:";
1330 PRINT B$:: GET B$: IF B$ < > " " AND B$ < > CHR$ (13) THEN Y$ = Y
$ + B$: GOTO 1330
1340 IF RIGHT$ (Y$,1) = CHR$ (8) THEN PRINT BELL$: "REINPUT ": Y$ = "":
GOTO 1320
1350 PRINT
1360 IF LEN (X$(L)) = 0 THEN XT = VAL (X$): XF = VAL (Y$): W = ABS (XF -
XT): YT = 0: X$(L) = CHR$ (W + 93): GOSUB 8040: GOTO 1170
1370 XC = VAL (X$): YC = - VAL (Y$): X = XC - XT: Y = YC - YT: IF ABS (X)
> 32 OR ABS (Y) > 32 THEN PRINT BELL$: "TO LARGE A DISPLACEMENT, INF
UT SMALLER VALUES": GOTO 1170
1380 GOSUB 8080
1390 XT = XC: YT = YC
1400 X$(L) = X$(L) + CHR$ (X + 93) + CHR$ (Y + 93): IF PF = 0 THEN X$(L)
= X$(L) + CHR$ (127): PF = 1
1410 GOTO 1170
1420 PRINT "CHARACTER WIDTH=": W
1430 PRINT BELL$: "CHARACTER O.K.?":: GET Q$: PRINT Q$: IF Q$ < > "Y" AND
Q$ < > "N" THEN 1430
1440 IF Q$ = "Y" AND FI THEN RETURN
1450 IF Q$ = "N" THEN PRINT BELL$: "RE-INPUT ";
1460 L = L + 1: GOTO 1120
2000 TEXT : HOME : PRINT "WRITE TO FILENAME:"; N$: PRINT "DISK DRIVE NO.":
DO: PRINT BELL$: REM PUT IT ON DISK DO
2010 PRINT "ARE THESE O.K.?":: GET A$: PRINT A$: IF A$ < > "Y" AND A$ <
> "N" THEN 2010
2020 IF A$ = "Y" THEN 2050
2030 PRINT BELL$: INPUT "FILENAME: "; N$
2040 PRINT BELL$: INPUT "WRITE TO DISK DRIVE#": DO: IF DO < 1 OR DO > 2 THEN
2040
2050 PRINT D$: "OPEN "; N$: ",D": DO
2060 PRINT D$: "DELETE "; N$
2070 PRINT D$: "OPEN "; N$
2080 PRINT D$: "WRITE "; N$
2090 FOR I = 0 TO L
2100 PRINT X$(I)
2110 NEXT I
2120 PRINT D$: "CLOSE "; N$
2130 TEXT : GOTO 100

```

```

3000 TEXT : HOME : PRINT : PRINT "*ROUTINES TO MODIFY A HERSEY FONT": PRINT
: PRINT TAB( 10);"FONTNAME:";N$
3010 PRINT : PRINT TAB( 5);"YOU MAY...": PRINT : PRINT TAB( 5);"1.APPEN
D TO A FONT"
3020 PRINT : PRINT TAB( 5);"2.INSERT IN THE MIDDLE OF A FONT": PRINT : PRINT
TAB( 5);"3.REPLACE A CHARACTER"
3030 PRINT : PRINT TAB( 5);"4.REMOVE A CHARACTER": PRINT : PRINT TAB( 5
);"5.EXIT"
3040 PRINT : PRINT BELL$; TAB( 5);"WHICH?": INPUT C
3050 IF C < 1 OR C > 5 THEN 3000
3060 IF C = 5 THEN FI = 0;L = LMAX: GOTO 4000
3070 IF FI = 0 THEN FI = 1: GOSUB 4000: GOTO 3090
3080 IF FI AND C > 1 THEN GOSUB 4010
3090 ON C GOTO 3100,3110,3110,3110
3100 FI = 0;C = 0;L = LMAX: TEXT : HOME : GOTO 1000
3110 IF MF THEN GOSUB 11000
3120 VTAB (21): PRINT "NOTE...FIRST CHARACTER IS NO.0"
3130 PRINT BELL$;"LOCATION TO ";
3140 ON C - 1 GOTO 3150,3200,3230
3150 PRINT "INSERT?": INPUT LO: IF LO < 0 OR LO > LMAX THEN PRINT BELL$;
"OUT OF RANGE": GOTO 3130
3160 LMAX = LMAX + 1
3170 FOR K = LMAX TO LO + 1 STEP - 1:X$(K) = X$(K - 1): NEXT K
3180 FOR L = LO + 1 TO LMAX: GOSUB 6000: NEXT : GOSUB 11000
3190 GOTO 3220
3200 PRINT "REPLACE?": INPUT LO: IF LO < 0 OR LO > LMAX - 1 THEN PRINT B
ELL$;"OUT OF RANGE": GOTO 3130
3210 GOSUB 11000
3220 L = LO: TEXT : HOME : GOSUB 1010;EF = 0: GOSUB 6000: GOTO 3000
3230 PRINT "DELETE?": INPUT LO: IF LO < 0 OR LO > LMAX THEN PRINT BELL$;
"OUT OF RANGE": GOTO 3130
3240 LMAX = LMAX - 1
3250 FOR K = LO TO LMAX:X$(K) = X$(K + 1): NEXT
3260 FOR L = LO TO LMAX: GOSUB 6000: NEXT : GOSUB 11000: GOTO 3000
4000 GOSUB 7000: REM GET FONT AND DISPLAY IT
4010 HGR : IF MF = 0 THEN FOR L = 0 TO LMAX: HTAB (12): VTAB (24): PRINT
"CHAR.NO.":L: GOSUB 6000: NEXT L: GOSUB 11000: GOTO 4030
4020 GOSUB 11000: IF N$ = 0$ THEN GOSUB 11000
4030 IF FI THEN RETURN
4040 VTAB (21): HTAB (10): PRINT N$
4050 PRINT BELL$;"WRITE TO DISK <W> OR RETURN TO MENU <M>": GET A$: PRINT
A$: IF A$ < > "W" AND A$ < > "M" THEN 4050
4060 IF A$ = "W" THEN 2000
4070 TEXT : HOME : GOTO 100
5000 TEXT : HOME : PRINT : PRINT "*ROUTINE TO EDIT INDIVIDUAL CHARACTERS"

5010 PRINT : PRINT "YOU WILL FIRST BE SHOWN ENTIRE FONT AND THEN ASKE
D TO CHOOSE THE CHARACTER TO EDIT."
5020 PRINT : PRINT "THE CHARACTER WILL BE DRAWN AS IS AND THEN YOU CAN
REDRAW IT BY EITHER INPUT- TING HERSEY VECTORS OR BY USING THE ED
ITING KEYS."
5030 PRINT BELL$: PRINT "READY?": GET A$: PRINT A$: IF A$ < > "Y" THEN
5000
5040 FI = 1: GOSUB 4000:FI = 0
5050 VTAB (24)
5060 PRINT BELL$;"NOTE...FIRST CHARACTER IS NO.0": INPUT "CHARACTER NO. T
O EDIT?":L: PRINT : IF L < 0 OR L > LMAX - 1 THEN PRINT BELL$;"OUT O
F RANGE": GOTO 5060
5070 PRINT : GOSUB 8000:X$ = "": PRINT TAB( 13);"OLD CHARACTER"
5080 W = ASC ( LEFT$ (X$(L),1)) - 93:XF = W - INT (W / 2):XT = - INT (

```



```

W / 2): GOSUB 8060
5090 PF = 0: FOR J = 2 TO LEN (X$(L)) STEP 2
5100 X = ASC ( MID$ (X$(L),J,1)) - 93: IF X = 34 THEN PF = NOT PF: J = J -
1: NEXT
5110 Y = ASC ( MID$ (X$(L),J + 1,1)) - 93
5120 GOSUB 8080: NEXT J
5125 PRINT "READY TO CHANGE": INPUT A$: IF A$ < > "Y" THEN 5000
5130 PRINT BELL$: "INPUT HERSHEY COOR.<H> OR USE CURSOR<C>?": GET Q$: IF
Q$ < > "H" AND Q$ < > "C" THEN 5130
5140 IF Q$ = "H" THEN FI = 1: GOSUB 1120: FI = 0: GOTO 5400
5150 GOSUB 8000
5160 PRINT "CURRENT WIDTH IS "; W: PRINT "LEFT MARKER AT: "; XT: PRINT "RIGH
T MARKER AT: "; XF
5170 PRINT BELL$: "ARE THESE OK?": GET A$: PRINT A$: IF A$ < > "Y" AND A
$ < > "N" THEN 5170
5180 IF A$ = "N" THEN PRINT BELL$: INPUT "LEFT MARKER: "; XT: PRINT BELL$
: INPUT "RIGHT MARKER: "; XF: W = XF - XT: GOTO 5160
5190 X$ = CHR$ (W + 93): GOSUB 8060
5200 POKE 33,5: POKE 32,34: PRINT " PEN": PRINT "MODE: "; POKE 33
,33: POKE 32,0: PF = 0
5210 SCALE= 1: ROT= 0: X = X1: Y = Y1: DRAW 1 AT X,Y: PRINT : PRINT "I,J,K,
M KEYS MOVE CURSOR U,R,L,D"
5220 PRINT "RETURN ENDS MOVE, / ENDS CHAR."
5230 PRINT "SPACE FLIPS PEN, E ENDS FONT": HTAB (37): PRINT CHR$ (95 -
17 * PF);
5240 DX = 0: DY = 0
5250 GET A$: PRINT BELL$: IF ASC (A$) < 73 OR ASC (A$) > 77 THEN 5320
5260 XDRAW 1 AT X,Y: ON ASC (A$) - 73 GOTO 5280,5290,5300,5300
5270 DY = DY - 1: Y = Y - 5: GOTO 5310
5280 DX = DX - 1: X = X - 5: GOTO 5310
5290 DX = DX + 1: X = X + 5: GOTO 5310
5300 DY = DY + 1: Y = Y + 5
5310 DRAW 1 AT X,Y: GOTO 5250
5320 IF A$ < > "E" AND A$ < > "/" AND A$ < > " " AND ASC (A$) < > 13
THEN 5250
5330 IF A$ = " " THEN PF = NOT PF: X$ = X$ + CHR$ (127): HTAB (37): PRINT
CHR$ (95 - 17 * PF): GOTO 5250
5340 IF ASC (A$) = 13 THEN X$ = X$ + CHR$ (DX + 93) + CHR$ (93 - DY): IF
PF THEN HPLLOT X1,Y1 TO X,Y
5350 IF ASC (A$) = 13 THEN X1 = X: Y1 = Y: GOTO 5210
5360 IF A$ = "/" THEN X$(L) = X$: IF PF = 1 AND X1 < > 140 + M * XF AND
Y1 < > 80 THEN X$(L) = X$(L) + CHR$ (127) + CHR$ (XF + (140 - X1) /
5 + 93) + CHR$ ((Y1 - 80) / 5 + 93)
5370 IF A$ = "/" AND LEN (X$(L)) = 1 THEN X$(L) = X$(L) + CHR$ (127) +
CHR$ (93) + CHR$ (93)
5380 IF A$ = "/" THEN PRINT BELL$: PRINT "CHARACTER O.K.?: GET Q$: PRINT
Q$: IF Q$ < > "Y" AND Q$ < > "N" THEN 5380
5390 IF Q$ = "N" THEN 5150
5400 POKE 33,40: GOSUB 11000: GOSUB 8000: GOSUB 11000
5410 IF A$ = "/" AND (FI OR EF) THEN RETURN
5420 IF A$ = "E" AND EF THEN EF = 0: RETURN
5430 PRINT BELL$: "FINISHED EDITING?": GET A$: PRINT A$: IF A$ < > "Y" AND
A$ < > "N" THEN 5430
5440 IF A$ = "N" AND FI THEN FI = 0: GOTO 5060
5450 IF A$ = "N" THEN FI = 1: GOSUB 4010: FI = 0: GOTO 5060
5460 L = LMAX: X$ = "E": PRINT " E": GOTO 1220
6000 HCOLOR= 0: Z = L - 50 * INT (L / 50): IF (Z / 50) = INT (Z / 50) AND
(L > 0) THEN PRINT BELL$: "STRIKE ANY KEY TO CONTINUE...": GET Q$: HGR
: REM DISPLAY ROUTINE
6010 IF LEN (X$(L)) = 0 THEN RETURN

```

```

6020 XP = 280 * (Z / 10 - INT (Z / 10)):YP = 32 * INT (Z / 10) + 16
6030 FOR I = 1 TO 14: SCALE= I: DRAW 1 AT XP + 14,YP: NEXT : HCOLOR= 3
6040 W = ASC ( MID$ (X$(L),1,1)) - 93
6050 XP = XP + INT ((28 - W) / 2)
6060 IF W = 0 THEN HCOLOR= 6:XP = XP - 5:DX = 10
6070 IF W = 0 THEN HPLLOT XP,YP TO XP + DX,YP
6080 HCOLOR= 3:PF = 0
6090 FOR J = 2 TO LEN (X$(L)) STEP 2
6100 DX = ASC ( MID$ (X$(L),J,1))
6110 DY = ASC ( MID$ (X$(L),J + 1,1))
6120 IF DX = 127 THEN PF = NOT (PF):J = J - 1: NEXT J
6130 DX = (DX - 93):DY = (DY - 93)
6140 IF LEN (X$(L)) < 5 THEN HCOLOR= 5
6150 IF PF THEN HPLLOT XP,YP TO XP + DX,YP - DY
6160 XP = XP + DX:YP = YP - DY: NEXT J
6170 HOME : VTAB 21
6180 RETURN
7000 HOME : IF N$ = 0$ AND MF = 1 THEN RETURN : REM READ FROM DISK DI
7010 PRINT "NOW READING FILE FROM DISK #":DI
7020 IF FI THEN PRINT : PRINT "ENTIRE FONT WILL BE DISPLAYED"
7030 MF = 0: RESTORE
7040 PRINT D$:"OPEN ";N$:",D":DI
7050 PRINT D$:"READ ";N$
7060 I = 0
7070 INPUT X$(I)
7080 IF X$(I) = "EOF" THEN 7100
7090 I = I + 1: GOTO 7070
7100 PRINT D$:"CLOSE ";N$:
7110 LMAX = I:O$ = N$: RETURN
8000 HGR : HCOLOR= 5: HPLLOT 65,5 TO 215,5 TO 215,155 TO 65,155 TO 65,5: REM
EDIT GRAPHICS ROUTINES
8010 HCOLOR= 6: HPLLOT 140,5 TO 140,15: HPLLOT 140,145 TO 140,155: HPLLOT 65
,80 TO 75,80: HPLLOT 205,80 TO 215,80
8020 HCOLOR= 3: FOR J = 10 TO 150 STEP 5: FOR K = 70 TO 210 STEP 5: HPLLOT
K,J: NEXT : NEXT
8030 HPLLOT 140,78 TO 140,82: HPLLOT 138,80 TO 142,80
8040 VTAB (24)
8050 RETURN
8060 M = 5: HCOLOR= 3: HPLLOT 140 + M * XT,75 TO 140 + M * XT,85: HPLLOT 140
+ XF * M,75 TO 140 + XF * M,85
8070 X1 = 140 + M * XT:Y1 = 80: RETURN
8080 IF PF THEN HPLLOT X1,Y1 TO X1 + M * X,Y1 - M * Y
8090 X1 = X1 + M * X:Y1 = Y1 - M * Y: RETURN
9000 TEXT : HOME : PRINT D$:"CATALOG,D":DI
9010 PRINT : PRINT BELL$:"STRIKE ANY KEY TO CONTINUE": GET A$: GOTO 100
10000 HOME : PRINT BELL$:"NICE WORKING WITH YOU": END
11000 READ F%,L%,D$: REM MEMORY LOCATIONS FOR MOVE
11010 FH% = F% / 256:FL% = F% - 256 * FH%: LH% = L% / 256:LL% = L% - 256 *
LH%:DH% = D% / 256:DL% = D% - 256 * DH%
11020 POKE 60,FL%: POKE 61,FH%: POKE 62,LL%: POKE 63,LH%: POKE 66,DL%: POKE
67,DH%
11030 POKE 70,0: POKE 71,0: POKE 58,44: POKE 59,254: REM SETUP YREG,XREG
,PCL,PCH
11040 CALL - 327:MF = NOT MF: IF MF = 0 THEN RESTORE
11050 RETURN
11060 DATA 8192,16383,16384,16384,24575,8192

```

Listing 2. Candy Apple variable listing.

```
*****
*
*          CANDY APPLE          *
*
*  -->TABLE OF VARIABLES<--    *
*
*****
```

A\$ - ANSWER STRING--ALSO USED TO ENTER HERSHEY X COORDINATE
 1010 1010 1010 1010 1020 1120 1150 1200 1200 1200 1200 1200 2010
 2010 2010 2010 2020 4050 4050 4050 4050 4060 5030 5030 5030 5125
 5125 5170 5170 5170 5170 5180 5250 5250 5250 5260 5320 5320 5320
 5320 5330 5340 5350 5360 5370 5380 5410 5420 5430 5430 5430 5430
 5440 5450 9010

B\$ - STRING USED TO ENTER HERSHEY Y COORDINATE
 1330 1330 1330 1330 1330

BELL\$ - CHR\$(7) SOUNDS SPEAKER
 30 80 90 120 150 1010 1040 1090 1190 1210 1230 1290 1310 1320
 1340 1370 1430 1450 2000 2030 2040 3040 3130 3150 3200 3230 4050
 5030 5060 5060 5130 5170 5180 5180 5250 5380 5430 6000 9010
 10000

C - NUMERICAL CHOICE INPUT
 120 130 130 140 180 1110 3040 3050 3050 3060 3080 3090 3100
 3140

D\$ - CHR\$(4) DOS CONTROL
 50 2050 2060 2070 2080 2120 7040 7050 7100 9000

D% - DESTINATION ADDRESS FOR MEMORY MOVE
 11000 11010 11010

DH% - DESTINATION HIGH BYTE
 11010 11010 11020

DI - DISK DRIVE FOR INPUT
 80 80 80 120 7010 7040 9000

DL% - DESTINATION LOW BYTE
 11010 11020

DO - DISK DRIVE FOR OUTPUT
 90 90 90 2000 2040 2040 2040 2050

DX - INCREMENTAL X
 5240 5280 5280 5290 5290 5340 6060 6070 6100 6120 6130 6130 6150
 6160

DY - INCREMENTAL Y
 5240 5270 5270 5300 5300 5340 6110 6130 6130 6150 6160

EF - EDIT FLAG 0= NO EDIT 1=EDIT UNDERWAY

1020 1020 1030 1150 1150 1150 1170 3220 5410 5420 5420

F% - STARTING ADDRESS FOR MEMORY MOVE ROUTINE
11000 11010 11010

FH% - STARTING ADDRESS HIGH BYTE
11010 11010 11020

FI - GENERAL PURPOSE FONT INPUT FLAG
1100 1150 1440 3060 3070 3070 3080 3100 4030 5040 5040 5140 5140
5410 5440 5440 5450 5450 7020

FL% - STARTING ADDRESS LOW BYTE
11010 11020

I - GENERAL INDEX
2090 2100 2110 6030 6030 7060 7070 7080 7090 7090 7110

J - GENERAL INDEX
5090 5100 5100 5100 5110 5120 6090 6100 6110 6120 6120 6120 6160
8020 8020

K - GENERAL INDEX
3170 3170 3170 3170 3250 3250 3250 8020 8020

L - INDEX FOR LOCATION IN FONT
1110 1130 1130 1140 1170 1170 1220 1220 1290 1290 1300 1300 1300
1310 1360 1360 1400 1400 1400 1400 1460 1460 2090 3060 3100 3180
3220 3260 4010 4010 4010 5060 5060 5060 5080 5090 5100 5110 5360
5360 5360 5370 5370 5370 5460 6000 6000 6000 6010 6040 6090 6100
6110 6140

L% - ENDING ADDRESS FOR MEMORY MOVE ROUTINE
11000 11010 11010

LH% - ENDING ADDRESS HIGH BYTE
11010 11010 11020

LL% - ENDING ADDRESS LOW BYTE
11010 11020

LMAX - LOCATION OF EOF CHARACTER--MAXIMUM CHARACTER IN FONT
1220 3060 3100 3150 3160 3160 3170 3180 3200 3230 3240 3240 3250
3260 4010 5060 5460 7110

LO - LOCATION TO INSERT, REPLACE, ETC.
3150 3150 3150 3170 3180 3200 3200 3200 3220 3230 3230 3230 3250
3260

M - MAGNIFICATION FOR HIGH RES ROUTINES
5360 8060 8060 8060 8060 8060 8070 8080 8080 8090 8090

MF - MOVE FLAG 0=XFER FROM P1 TO P2 1=XFER FROM P2 TO P1
3110 4010 7000 7030 11040 11040 11040

N# - FONT NAME (CURRENT)
150 160 160 160 165 1000 1120 2000 2030 2050 2060 2070 2080
2120 3000 4020 4040 7000 7040 7050 7100 7110

O# - FONT NAME (PREVIOUS)

150 160 165 4020 7000 7110

PF - PEN FLAG 0=PEN UP 1=PEN DOWN

1130 1290 1290 1400 1400 5090 5100 5100 5200 5230 5330 5330 5330
5340 5360 6080 6120 6120 6150 8080

Q# - STRING FOR QUESTION ANSWERS

1090 1090 1090 1230 1230 1230 1230 1240 1250 1430 1430 1430 1430
1440 1450 5130 5130 5130 5140 5380 5380 5380 5380 5390 6000

W - LENGTH (WIDTH) OF CHARACTER IN FONT

1360 1360 1420 5080 5080 5080 5080 5160 5180 5190 6040 6050 6060
6070

X - X LOCATION IN CHARACTER COORDINATE SPACE

1370 1370 1400 5100 5100 5210 5210 5260 5280 5280 5290 5290 5310
5340 5350 8080 8090

X# - STRING CONTAINING CURRENT CHARACTER

1140 1150 1180 1200 1200 1210 1210 1220 1230 1290 1300 1310 1360
1370 5070 5190 5330 5330 5340 5340 5360 5460

X#(*) - STRING ARRAY FOR FONT

50 1130 1220 1290 1290 1300 1300 1300 1310 1360 1360 1400 1400
1400 1400 2100 3170 3170 3250 3250 5080 5090 5100 5110 5360 5360
5360 5370 5370 5370 6010 6040 6090 6100 6110 6140 7070 7080

X1 - HIRES X LOCATION

5210 5340 5350 5360 5360 8070 8080 8080 8090 8090

XC - CURRENT X COORDINATE VALUE

1370 1370 1390

XF - FINAL X COORDINATE OF CHARACTER

1300 1360 1360 5080 5160 5180 5180 5360 5360 8060 8060

XP - HIRES X POSITION

6020 6030 6050 6050 6060 6060 6070 6070 6150 6150 6160 6160

XT - TEMPORARY X COORDINATE

1300 1360 1360 1370 1390 5080 5160 5180 5180 8060 8060 8070

Y - Y LOCATION IN CHARACTER COORDINATE SPACE

1370 1370 1400 5110 5210 5210 5260 5270 5270 5300 5300 5310 5340
5350 8080 8090

Y# - CURRENT Y COORDINATE STRING FOR INPUT

1180 1330 1330 1340 1340 1360 1370

Y1 - HIRES Y COORDINATE

5210 5340 5350 5360 5360 8070 8080 8080 8090 8090

YC - CURRENT Y COORDINATE

1370 1370 1390

YP - HIRES Y POSITION

6020 6030 6070 6070 6150 6150 6160 6160

YT - TEMPORARY Y COORDINATE

1300 1360 1370 1390

Z - CHARACTER INDEX FOR DISPLAY ROUTINE
1130 3000 6000 6000 3020 3020 3020

END OF VAR. LIST

Listing 3. Catalog of Candy Apple disk.

DISK VOLUME 254

```
*A 033 CANDY APPLE
*E 003 LOMEM:
*T 007 MATH SYMBOLS
*T 004 CARTO NUMBERS
*T 005 CARTO SMALL
*T 005 CARTO CAPS
*T 007 INDEX NUMBERS
*T 009 INDEX SMALL
*T 008 INDEX CAPS
*T 009 INDEX GREEK
*T 005 SIMPLEX NUMBERS
*T 006 SIMPLEX SMALL
*T 005 SIMPLEX CAPS
*T 006 SIMPLEX GREEK
*T 007 COMPLEX NUMBERS
*T 009 COMPLEX SMALL
*T 009 COMPLEX CAPS
*T 010 COMPLEX GREEK
*T 008 SCRIPT NUMBERS
*T 009 SCRIPT SMALL
*T 012 SCRIPT CAPS
*T 010 GOTHIC NUMBERS
*T 011 GOTHIC SMALL
*T 020 GOTHIC CAPS
A 035 CA2
*T 007 CANDY APPLE VFILE
```

1

Listing 4. Candy Wrapper program.

```

10 TEXT : HOME : HTAB (14): VTAB (08): PRINT "CANDY WRAPPER"
20 PRINT CHR$(4);"ERUN LOMEM:"; & LOMEM: 16384: REM RELOCATES A/S TO
   START AT $4000 (ABOVE HGR 1)
30 BELL$ = CHR$(7)
40 D$ = CHR$(4): DIM X$(160): REM SAVE SPACE FOR 5 FONTS OF 32 CHARACTE
   RS
50 DEF FN A(A) = 8192 + 40 * INT (A / 64) + 128 * INT ((A - 64 * INT
   (A / 64)) / 8) + 1024 * (A - 8 * INT (A / 8))
60 POKE 768,01: POKE 769,00: POKE 770,04: POKE 771,00: POKE 772,58: POKE
   773,36: POKE 774,45: POKE 775,54: POKE 776,07: POKE 777,0: POKE 232,0
   0: POKE 233,03: REM LOAD SHAPE TABLE FOR HIRES CURSOR
70 ONERR GOTO 12000
80 X = 139:Y = 95:FF = 0
90 TEXT : HOME : HTAB (14): VTAB (08): PRINT "CHARACTER PLOT"
100 PRINT BELL$: INPUT "READ FROM DISK DRIVE:";DI: IF DI < 1 OR DI > 2 THEN
   100
110 PRINT BELL$: INPUT "WRITE TO DISK DRIVE:";DO: IF DO < 1 OR DO > 2 THEN
   110
120 PRINT BELL$: INPUT "FONTS FROM DISK DRIVE:";DF: IF DF < 1 OR DF > 2 THEN
   120
130 TEXT : HOME : HTAB (10): VTAB (06): PRINT "OPTIONS..."
140 PRINT : PRINT "1. CHANGE DISK DRIVES": PRINT "2. CATALOG DISK": PRINT
   "3. SET ENVIRONMENT"
150 PRINT "4. LOAD HIRES PIX": PRINT "5. SAVE HIRES PIX": PRINT "6. ADD T
   EXT TO PIX": PRINT "7. CHANGE FONT": PRINT "8. CLEAR HIRES SCREEN": PRINT
   "9. DISPLAY CURRENT PICTURE": PRINT "10. QUIT"
160 PRINT BELL$: INPUT "WHICH--> ";C: IF C < 1 OR C > 10 THEN 160
170 ON C GOTO 90,1000,8000,2000,2000,3000,4000,5000,6000,7000
1000 TEXT : HOME
1010 PRINT "WHICH DRIVE ";: INPUT D
1030 PRINT D$;"CATALOG,D";D
1040 PRINT : PRINT BELL$;"STRIKE ANY KEY TO CONTINUE";: GET A$: GOTO 130
2000 HOME : HTAB (5): VTAB (10): INPUT "FILENAME OF PICTURE-->";N$
2010 ON C - 3 GOTO 2020,2030
2020 HGR : POKE - 16302,0:X = 139:Y = 95: PRINT D$;"ELOAD ";N$;"",D";DI: FOR
   I = 1 TO 2000: NEXT : GOTO 130
2030 PRINT D$;"BSAVE ";N$;"",A$20 00,L$2000,D";DO
2040 PRINT D$;"LOCK ";N$; GOTO 130
3000 IF FF = 0 THEN PRINT "NEED FONTS TO CONTINUE...": FOR I = 1 TO 1000
   : NEXT : GOTO 4000
3010 TEXT : HOME : PRINT "PROCEDURE TO ADD TEXT TO PICTURE"
3020 PRINT : PRINT "1. INPUT TEXT TO ADD": PRINT "2. POSITION CURSOR USIN
   G I,J,K,M KEYS": PRINT "NOTE:KEY MAY BE PRECEDED BY A NUMBER, E.G.
   50I MOVES 50 SPACES RIGHT."
3030 PRINT "3. STRIKE CTRL-P TO PRINT TEXT": PRINT "4. <ESC> TO RETURN TO
   MENU, <SPACE> TO CHANGE TEXT."
3040 PRINT : PRINT "STRIKE ANY KEY TO START-->";: GET A$: IF ASC (A$) =
   27 THEN 130
3050 GOSUE 20000
3060 SCALE= 1: ROT= 0: HCOLOR= 7: POKE - 16304,0: POKE - 16297,0: POKE
   - 16302,0
3070 Z = 0:Z$ = "0": GOSUE 25000: DRAW 1 AT X,Y
3080 GET A$: PRINT BELL$: IF (A$ > ",") AND (A$ < > ".") AND (A$ < ":") THEN
   Z$ = Z$ + A$:Z = VAL (Z$): GOTO 3080
3090 IF ASC (A$) < 73 OR ASC (A$) > 77 THEN 3190
3100 GOSUE 30000: FOR I = 0 TO Z: IF (X > 10) AND (X < 270) AND (Y > 10) AND
   (Y < 182) THEN ON ASC (A$) - 72 GOTO 3110,3130,3150,3150,3170
3110 Y = Y - 1: IF Y = 10 THEN Y = 11

```

```

3120 NEXT I: GOTO 3070
3130 X = X - 1: IF X = 10 THEN X = 11
3140 NEXT I: GOTO 3070
3150 X = X + 1: IF X = 270 THEN X = 269
3160 NEXT I: GOTO 3070
3170 Y = Y + 1: IF Y = 182 THEN Y = 181
3180 NEXT I: GOTO 3070
3190 IF ( ASC (A$) < > 16) AND ( ASC (A$) < > 32) AND ( ASC (A$) < > 2
7) THEN 3070
3200 IF ASC (A$) = 27 THEN 130
3210 IF ASC (A$) = 32 THEN 3000
3220 GOSUB 30000: GOSUB 22000: GOTO 3000
4000 REM LETTER FONTS
4010 HOME
4020 PRINT : PRINT TAB( 10);: INVERSE : PRINT "INPUT LETTER FONTS": PRINT
: NORMAL : PRINT TAB( 11);"FONTS AVAILABLE:"
4030 PRINT : PRINT TAB( 10);"<1> INDEX": PRINT TAB( 10);"<2> SIMPLEX"
: PRINT TAB( 10);"<3> COMPLEX": PRINT TAB( 10);"<4> CARTOGRAPHIC"
: PRINT TAB( 10);"<5> SCRIPT": PRINT TAB( 10);"<6> GOTHIC": PRINT
: PRINT
4040 I = 1
4050 N$ = " NUMBERS": PRINT : INPUT "NUMBER FONT <1-6>:";N:N = INT (N): IF
N < 1 OR N > 6 THEN PRINT "REINPUT ";; GOTO 4050
4060 GOSUB 4140:
4070 N$ = " CAPS": PRINT : INPUT "UPPER CASE FONT <1-6>:";N:N = INT (N): IF
N < 1 OR N > 6 THEN POKE "REINPUT ";; GOTO 4070
4080 GOSUB 4140
4090 N$ = " SMALL": PRINT : INPUT "LOWER CASE FONT <1-6>:";N:N = INT (N):
IF N < 1 OR N > 6 THEN PRINT "REINPUT ";; GOTO 4090
4100 GOSUB 4140
4110 N$ = " GREEK": PRINT : INPUT "GREEK FONT <1-3>:";N:N = INT (N): IF N
< 1 OR N > 3 THEN PRINT "REINPUT ";; GOTO 4110
4120 GOSUB 4140
4130 PRINT :N$(5) = "MATH SYMBOLS": PRINT N$(5);" ALSO BEING LOADED": GOTO
4210
4140 IF N = 1 THEN N$(I) = "INDEX"
4150 IF N = 2 THEN N$(I) = "SIMPLEX"
4160 IF N = 3 THEN N$(I) = "COMPLEX"
4170 IF N = 4 THEN N$(I) = "CARTO"
4180 IF N = 5 THEN N$(I) = "SCRIPT"
4190 IF N = 6 THEN N$(I) = "GOTHIC"
4200 N$(I) = N$(I) + N$:I = I + 1: RETURN
4210 PRINT : FLASH : PRINT "NOW LOADING FONTS": NORMAL
4220 FOR I = 1 TO 2: PRINT N$(I);" ";; NEXT I: PRINT
4230 FOR I = 3 TO 4: PRINT N$(I);" ";; NEXT I: PRINT : PRINT "MATH SYME
OLS"
4240 N = 0: FOR I = 1 TO 5
4250 PRINT D$;"OPEN ";N$(I);",D";DF
4260 PRINT D$;"READ ";N$(I)
4270 FOR JJ = 1 TO 32
4280 INPUT X$(N)
4290 N = N + 1
4300 NEXT JJ
4310 PRINT D$;"CLOSE ";N$(I)
4320 NEXT I:FF = 1
4330 HOME
4340 GOTO 130
5000 HGR : GOTO 130
6000 POKE - 16304,0: POKE - 16302,0: GET A$: GOTO 130
7000 HOME : PRINT BELL$;"NICE WORKING WITH YOU": END

```



```

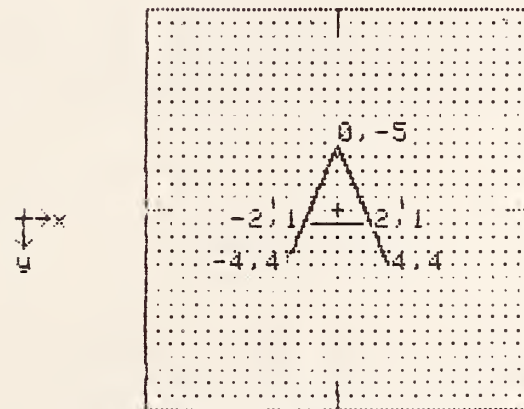
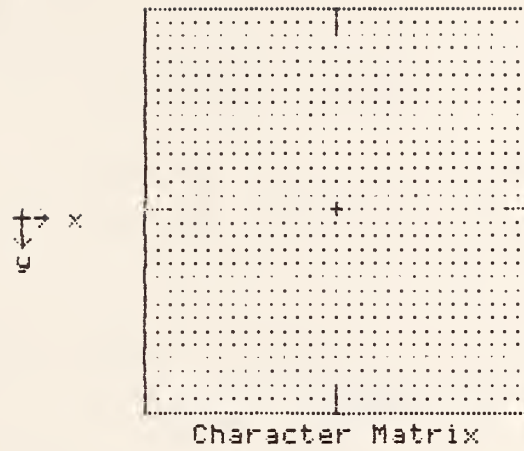
8000 TEXT : HOME : PRINT "SET DRAWING ENVIRONMENT":BF = 0:DP = 0
8010 PRINT : PRINT "COLORS AVAILABLE..."
8020 PRINT "0. BLACK1": PRINT "1 . GREEN": PRINT "2. VIOLET": PRINT "3. W
HITE1": PRINT "4. BLACK2": PRINT "5. ORANGE": PRINT "6. BLUE": PRINT
"7. WHITE2"
8025 PRINT "8. NONE -- BACKGROUND ONLY"
8030 PRINT : INPUT "BACKGROUND COLOR:";BC: IF BC < 0 OR BC > 7 THEN BF =
1:BC = 0
8040 PRINT : INPUT "FOREGROUND COLOR:";FC: IF FC < 0 OR FC > 7 THEN 8040
8045 PRINT : INPUT "SINGLE<1> OR DOUBLE<2> PRECISION:";N: IF N < 1 OR N >
2 THEN 8045
8048 IF N = 1 THEN 8060
8050 DP = 1: PRINT : INPUT "CONAST COLOR:";CC: IF CC < 0 OR CC > 7 THEN 8
050
8060 GOTO 130
11000 READ F%,L%,D%: REM MEMORY LOCATIONS FOR MOVE
11010 FH% = F% / 256:FL% = F% - 256 * FH%: LH% = L% / 256:LL% = L% - 256 *
LH%:DH% = D% / 256:DL% = D% - 256 * DH%
11020 POKE 60,FL%: POKE 61,FH%: POKE 62,LL%: POKE 63,LH%: POKE 66,DL%: POKE
67,DH%
11030 POKE 70,0: POKE 71,0: POKE 58,44: POKE 59,254: REM SETUP YREG,XREG
,PCL,PCH
11040 CALL - 327:MF = NOT MF: IF MF = 0 THEN RESTORE
11050 RETURN
11060 DATA 8192,16383,16384,16384,24575,8192
12000 REM ERROR HANDLING ROUTINES
12010 GOOF = PEEK (222)
12020 PRINT : PRINT BELL$;"ERROR NO.":GOOF;" ENCOUNTERED": PRINT "ERROR H
ANDLER ACTIVE...":BELL$: FOR Z = 1 TO 1000: NEXT
12030 IF GOOF = 53 THEN PRINT : PRINT BELL$;"NEED FONTS TO CONTINUE":BEL
L$: FOR ZZ = 1 TO 1000: NEXT ZZ:B$(J + 6) = B$(J): HOME :B$(J) = "F":
GOSUB 3000: RESUME
12040 IF (GOOF = 5) OR (GOOF = 6) THEN PRINT "FILE NOT FOUND": FOR ZZ =
1 TO 2000: NEXT : GOTO 130
12060 IF GOOF = 9 THEN PRINT BELL$;"DISK FULL,INSERT NEW DISKETTE":BELL$
12070 IF GOOF = 10 THEN PRINT BELL$;"WARNING! ", "N$:" IS LOCKED": PRINT
"DO YOU WISH TO DESTROY OLD FILE": INPUT A$: IF LEFT$ (A$,1) = "N" THEN
GOTO 130
12080 IF LEFT$ (A$,1) = "Y" THEN PRINT D$;"UNLOCK "N$
12090 IF GOOF = 255 THEN STOP
12100 RESUME
20000 REM *** TEXT GENERATOR ***
20020 PRINT : PRINT "CHARACTER STRING: ";:LC = 0:SC = 0:R$ = ""
20050 PRINT BELL$:: GET T$: IF T$ = CHR$ (13) THEN LC = 0: NORMAL : GOTO
20110
20060 IF T$ = CHR$ (7) OR T$ = CHR$ (19) THEN FLASH :R$ = R$ + T$:SC =
1: GOTO 20050
20070 IF T$ = CHR$ (27) THEN LC = NOT (LC): GOTO 20050
20080 IF NOT (LC) AND NOT (SC) THEN INVERSE
20090 IF LC AND NOT (SC) AND ASC (T$) > 63 THEN NORMAL :T$ = CHR$ ( ASC
(T$) + 128)
20100 PRINT T$::R$ = R$ + CHR$ ( ASC (T$)):SC = 0: GOTO 20050
20110 PRINT : PRINT BELL$: INPUT "SIZE :";IW:IW = INT (IW): IF IW < 1 OR
IW > 10 THEN PRINT BELL$;"REINPUT :": GOTO 20110
20130 PRINT BELL$: INPUT "HORIZ.<H> OR VERT.<V> CHARACTERS ?":L$: IF L$ <
> "H" AND L$ < > "V" THEN PRINT BELL$;"REINPUT :": GOTO 20130
20140 IV = 0: IF L$ = "V" THEN IV = 06

```

```

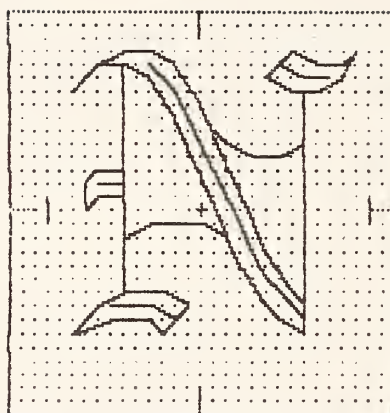
20180 IF LEN (R$) = 0 THEN PRINT BELL$;"ERROR-REINPUT:"; GOTO 20030
20190 RETURN
22000 REM TEXT STRING DECODER
22010 HCOLOR= BC:SIZE = 0:W = 0
22020 PRINT : PRINT : FOR IC = 1 TO LEN (R$)
22030 P$ = MID$ (R$,IC,1):P = ASC (P$): IF P = 7 OR P = 19 THEN IC = IC +
1:P$ = MID$ (R$,IC,1)
22040 REM *** MAKE HERSHEY VECTORS ***
22050 IF P$ = "" THEN PRINT BELL$;"ERROR-REINPUT "':R$ = "': GOTO 20030
22060 L = ASC (P$) - 32
22070 IF (P = 7 OR P = 19) AND (L > 95) THEN L = L - 128
22080 IF P = 7 THEN L = L + 64
22090 IF P = 19 THEN L = L + 96
22100 IF L > 159 THEN L = L - 96
22110 X$ = X$(L)
22120 IF SIZE = 0 THEN 23000
22130 PF = 0: HCOLOR= FC
22140 FOR G = 2 TO LEN (X$(L)) STEP 2
22150 DX = ASC ( MID$ (X$(L),G,1)) - 93
22160 DY = ASC ( MID$ (X$(L),G + 1,1)) - 93
22170 IF DX = 34 AND LEN (X$(L)) > 4 THEN PF = NOT (PF)
22180 IF DX = 34 THEN G = G - 1: NEXT G
22190 DX = DX * IW:DY = - DY * IW
22200 IF IV > 0 THEN TEMP = DX:DX = DY:DY = - TEMP
22210 IF PF THEN HPLOT X,Y TO X + DX,Y + DY
22215 IF PF AND DP THEN HCOLOR= CC:X = X + 1: HPLOT X,Y TO X + DX,Y + DY
: X = X - 1
22220 X = X + DX:Y = Y + DY
22230 NEXT G
22240 NEXT IC
22250 FOR I = 1 TO 2000: NEXT : RETURN
23000 W = W + ( ASC ( LEFT$ (X$,1)) - 93) * IW
23010 IF IV = 0 AND X + W > 278 THEN 23040
23020 IF IV > 0 AND Y - W < 2 THEN 23040
23030 NEXT IC:SIZE = 1: IF BF THEN 22020
23032 IF IV = 0 THEN FOR I = - 15 TO 15: HPLOT X - 2,Y + I * IW TO X +
2 + W * IW,Y + I * IW: NEXT
23034 IF IV > 0 THEN FOR I = - 15 TO 15: HPLOT X + I * IW,Y + 2 TO X +
I * IW,Y - 2 - W * IW: NEXT
23036 GOTO 22020
23040 TEXT : HOME : PRINT "TEXT TOO LONG...":BELL$:BELL$: GOTO 3020
25000 YU = FN A(Y - 1):YM = FN A(Y):YL = FN A(Y + 1)
25010 XC = INT (X / 7) - 1
25020 FOR I = 0 TO 2
25030 U(I) = PEEK (YU + XC + I)
25040 M(I) = PEEK (YM + XC + I)
25050 L(I) = PEEK (YL + XC + I)
25060 NEXT I
25070 RETURN
30000 FOR I = 0 TO 2
30010 POKE YU + XC + I,U(I)
30020 POKE YM + XC + I,M(I)
30030 POKE YL + XC + I,L(I)
30040 NEXT I
30050 RETURN

```



Carto A : Hershey Char No.1

Fig.1. Cartographic letter A showing coordinate system.



Gothic N : Hershey Char. No.3514

Fig.2. Hires display of English gothic N.

\pm \mp \times \cdot \div \neq \equiv $<$ $>$ \leq
 \geq \propto \sim \wedge $\sqrt{\quad}$ $[\quad]$ \rightarrow \uparrow \leftarrow
 \downarrow ∂ ∇ \S \int \oint ∞ $\{$ $\}$ \dagger
 \ddagger \in

Math Symbols

\dots $!$ $"$ $\#$ $\$$ $\%$ $\&$ $'$ $($ $)$
 $*$ $+$ $,$ $-$ $.$ $/$ 0 1 2 3
 4 5 6 7 8 9 $:$ $;$ $<$ $=$
 $>$ $?$

Carto Numbers

\circ a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z \cdot \circ $\{$
 $\}$ $,$

Carto Small

\circ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z Φ Ψ \pm
 \int Ω

Carto Caps

Fig.3. Math symbols and Carto fonts.

— ! " # \$ % & ' ()
 * + , - . / 0 1 2 3
 4 5 6 7 8 9 : ; < =
 > ?

Index Numbers

° a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z † ‡ {
 } ★

Index Small

@ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z Ω ℧ ±
 ∫ §

Index Caps

Ω α β γ δ ε ζ η θ ι
 κ λ μ ν ξ ο π ρ σ τ
 υ φ χ ψ ω Σ Π Δ Λ Γ
 © ≡

Index Greek

Fig. 4. Index font.

_ ! " # \$ % & ' ()
 * + , - . / 0 1 2 3
 4 5 6 7 8 9 : ; < =
 > ?

Simplex Numbers

♠ a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z ♥ ♦ [
] ♣

Simplex Small

@ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z , ' ±
 ∫ ∞

Simplex Caps

Ω α β γ δ ε ζ η θ ι
 κ λ μ ν ξ ο π ρ σ τ
 υ φ χ ψ ω Σ Π Δ Υ Γ
 Θ Χ

Simplex Greek




Fig. 5. Simplex font.

_ ! " # \$ % & ' ()
 * + , - . / 0 1 2 3
 4 5 6 7 8 9 : ; < =
 > ?

Complex Numbers

° a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z † ‡ §
 }

Complex Small

@ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z CR 1982 
 

Complex Caps

Ω α β γ δ ε ζ η θ ι
 κ λ μ ν ξ ο π ρ σ τ
 υ φ χ ψ ω Σ Π Δ Ξ Γ
 © X

Complex Greek

Fig. 6. Complex font.

— ! " # \$ % & ' ()
 * + , - . / 0 1 2 3
 4 5 6 7 8 9 : ; < =
 > ?

Gothic Numbers

° a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z — — {
 } —

Gothic Small

@ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z — — ±
 ∫

Gothic Caps

Fig. 7. Gothic font.

— ! " # \$ % & ' ()
 * + , — . / 0 1 2 3
 4 5 6 7 8 9 : ; < =
 > ?

Script Numbers

° a b c d e f g h i
 j k l m n o p q r s
 t u v w x y z {
 } —

Script Small

@ A B C D E F G H I
 J K L M N O P Q R S
 T U V W X Y Z — — ±
 ∫ —

Script Caps

Fig. 8. Script font.

Candy Apple
C. E. Dick
&
J. Hilsenrath
Hershey Characters
for the Apple II

Fig.9. Candy Apple logo produced by Candy Wrapper.

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5. AUTHOR(S) C. E. Dick and J. Hilsenrath			
6. PERFORMING ORGANIZATION (If joint or other than NBS, see instructions) NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234			7. Contract/Grant No. 8. Type of Report & Period Covered Final
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10. SUPPLEMENTARY NOTES <input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.			
11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here) Two programs are described that allow for the storage and manipulation of digitized fonts of graphic arts symbols and characters on the Apple II computer system. These fonts are based on the work of A. V. Hershey and provide the user with a repertory of digitized characters suitable for use in the preparation of camera-ready illustration in the laboratory environment. The programs described contain routines for reading files of the Hershey coordinates, storing them as text files, displaying them as individual characters or combined text on the high resolution display, and two methods for editing them or creating special symbols and graphics.			
12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons) Applesoft basic programs; camera-ready illustrations; digitized graphic symbols; Hershey character fonts; microcomputers.			
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